Lesson 11

The RAM Model

Goal

To familiarize you with the RAM model, its recommended uses and options, and its most useful outputs.

Objectives

After completing this lesson, you should be able to:

- State the plume distribution of the RAM model.
- Describe the terrain correction in RAM.
- State the current recommended regulatory use of the RAM model.
- Identify the dispersion curves that RAM uses to simulate dispersion in urban areas.
- Identity the number of stacks that can be analyzed by RAM.

Introduction

The next model discussed is the RAM model, also called the urban multisource model. The RAM model was originally designed for both rural and urban applications, but now it is recommended for point and area sources in urban situations only.

Plume Characteristics

The RAM urban model is a Gaussian plume model that assumes that the source and meteorological conditions are steady-state. The RAM model will estimate concentrations for averaging times from an hour to a year. The basic time period for calculations is one hour.

The RAM model is based on dispersion coefficients different from those of Pasquill-Gifford. The RAM dispersion curves, shown in Figure 11-1, were derived by Briggs from tracer experiments conducted in St. Louis by McElroy and Pooler. These dispersion curves are representative of an urban area. Figure 11-1 compares the RAM urban curves to the rural curves of Pasquill-Gifford. It can be seen that, in general, the urban curves represent a greater rate of dispersion caused by the increased turbulence found in urban areas.

The RAM model uses Briggs' equations for plume rise. There is no terrain correction in RAM because the surrounding area is assumed to be perfectly flat.

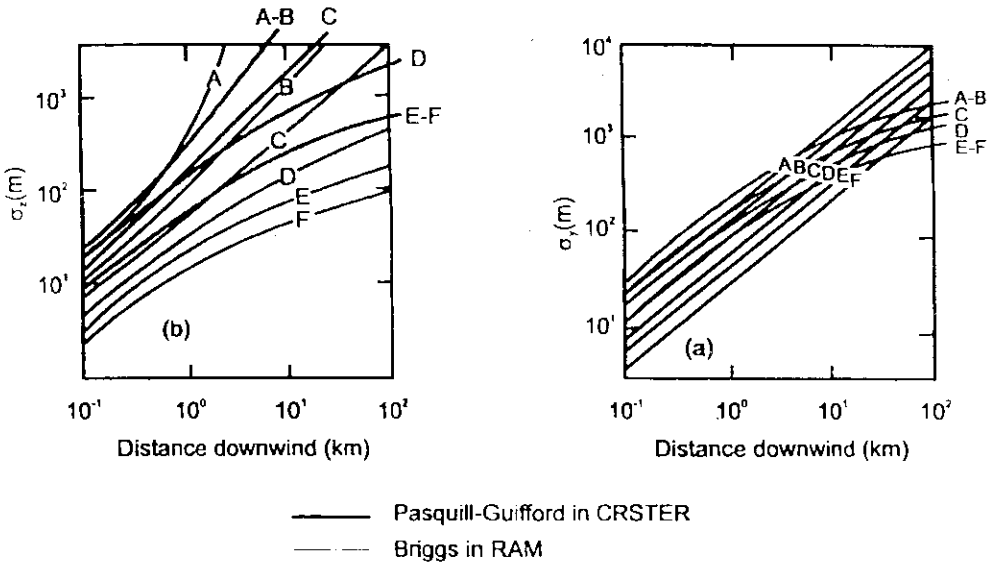

Figure 11-1. Briggs (Urban) And Pasquill-Gifford (Rural) Dispersion Curves

Model Inputs

The RAM model requires hourly meteorological data and emission information. The same preprocessed meteorological data tape described for CRSTER is used as input for the RAM model. Meteorological data include hourly values of wind direction and speed, temperature, stability class, and mixing height. Emission information consists of emission rate, physical stack height, stack diameter, stack-gas exit velocity, stack-gas temperature, and stack coordinates. The information required is the same as for other models already discussed. RAM is a true multiple source model, and the coordinates for all stacks are necessary to calculate the geometry between arbitrary source and receptor locations. Required information for area sources includes:

coordinates, size, emission rate, and height of emissions. The model also calculates a representative wind speed at stack height using the power law formula described in Lesson 9.

The model will allow the user to input a total of 250 stacks—known as point sources—and 100 area sources. Each stack may be of a different height, and a total of three area source release heights may be selected. This selection of release heights allows the model to represent several different types of area sources for an urban area.

Limitations

The model does not treat any aspects of terrain, physical removal, fumigation, building downwash, or multiple pollutants.

Options

Users should set the regulatory "default option" to automatically select: stack-tip downwash, final plume rise, buoyancy-induced dispersion, calm wind treatment, appropriate wind profile exponents, and the appropriate value for pollutant half-life (transformation of sulfur dioxide).

Model Outputs

RAM is recommended for multiple point and area source model applications in urban areas and for refined analyses only. The user should exercise caution in running the RAM model; because of internal program calculations, the number of point sources, area sources, receptors, and number of days of analysis should be kept at an absolute minimum. The RAM model abbreviated user's guide and preprocessed meteorological data are available via modem downloading to registered users on the EPA SCRAM BBS. The model can be run on a desktop personal computer meeting the specifications provided on SCRAM.

Figures 11-2 and 11-3 are examples of RAM runs involving typical site situations. Note that unlike the CRSTER model, RAM output does not use scientific notation for concentration values. Note that the data in Figure 11-2 are for only two hours, not the 8,760 hours in a year, and that Figure 11-3 provides information only for the first of these two hours. The concentration values are ranked for easy inspection, however, and the contribution of the various sources to each receptor is printed out.

RUN BY ED KRENSHAW, AIR & HAZARDOUSWATER. DIV., REGION XV, EPA (1 JAN 78)
EMISSIONS: TEST CITY, 1973
SFC MET DATA: TEST CITY 1973; UPPER AIR: TEST CITY 1973

INPUT HOUR	MET DATA THETA (DEG)	73/ SPEED (M/S)	1 MIXING HEIGHT (M)	TEMP (DEG-K)	STABILITY CLASS
1	33.00	6.17	429.11	269.82	4
2	23.00	4.63	401.70	271.48	4

RESULTANT MET CONDITIONS

WIND DIRECTION = 28.71
AVERAGE WIND SPEED = 5.40
WIND PERSISTENCE = .996

RESULTANT WIND SPEED = 5.38
AVERAGE TEMP = 270.65
MODAL STABILITY = 4

SIGNIFICANT POINT RECEPTIONS

RECEPTOR		#	EAST	NORTH	PREDICTED MAX CONC.	MAX. DIST	EFF. HT	U(PHY HT)
3	P	7	564.43	4407.01	39.39	.902	156.385	8.026
4	P	7	564.16	4406.52		1.804	156.385	8.026
5	P	5	579.45	4403.16	839.47	.166	32.007	6.281
6	P	5	579.40	4403.07		.331	32.007	6.281
7	P	8	577.38	4401.21	448.58	.249	47.506	6.890
8	P	8	577.30	4401.08		.499	47.506	6.890
9	P	9	576.67	4400.55	619.39	.276	52.296	4.753
10	P	9	576.59	4400.80		.551	52.296	4.753
11	P	11	582.94	4400.80	427.63	.187	35.952	6.263
12	P	11	582.89	4400.70		.374	35.952	6.263

SIGNIFICANT POINT RECEPTIONS

RECEPTOR		#	EAST	NORTH
13	A	4	578.42	4399.94
14	A	3	576.4	4399.95
15	A	6	578.4	4401.96
16	A	9	578.43	4405.95
17	A	2	574.43	4399.96
18	A	10	580.41	4405.92
19	A	8	574.43	4405.96
20	A	7	570.87	4403.94
21	A	13	582.41	4403.92
22	A	12	580.41	4403.92

Figure 11-2. Example RAM Runs

RUN BY ED KRENSHAW, AIR & HAZARDOUSWATER. DIV., REGION XV, EPA (1 JAN 78)
EMISSIONS: TEST CITY, 1973
SFC MET. DATA: TEST CITY 1973; UPPER AIR: TEST CITY 1973

SUMMARYCONCENTRATION TABLE (MICROGRAMS/M**3) 73/ 1

HOUR	THETA (DEG)	SPEED (M/S)	MIXING HEIGHT (M)	TEMP (DEG-K)	STABILITY CLASS
1	33.00	6.17	429.11	269.82	4

AREA HTS= 11., 14., 19.; SEPARATION HTS= 12., 16.

RECEPTOR NO	EAST	NORTH	TOTAL FROM SIGNIF PT	TOTAL FROM ALL PT	TOTAL FROM SIGNIF AREA	TOTAL FROM ALL AREA	TOTAL FROM ALL SRCS	CONCENTR RANK
1 I 0	566.00	4405.00	.0000	.0000	.0000	.0000	.0000	41
2 I 0	564.00	4401.50	.0000	.0000	.0000	.0000	.0000	40
3 P 7	564.43	4407.01	35.7987	35.7987	.0000	.0000	35.7987	11
4 P 7	564.16	4406.52	18.2026	18.2024	.0000	.0000	18.2024	15
5 P 5	579.45	4403.16	723.7571	723.7571	1.4215	1.4667	725.2238	1
6 P 5	579.40	4403.07	368.0487	368.0487	1.4465	1.4929	369.5415	5
7 P 8	577.38	4401.21	431.7621	432.2024	2.7281	2.7281	434.9305	3
8 P 8	577.30	4401.8	204.7343	205.1913	2.8280	2.8280	208.0193	7
9 P P	576.67	4400.55	710.0658	712.6823	2.9602	2.9602	715.6425	2
10 P 9	576.59	4400.40	291.1613	293.7612	3.0427	3.0427	296.8038	6
11 P 11	582.94	4400.80	433.3493	433.3493	.0000	.0483	433.3975	4
12 P 11	582.89	4400.70	194.8263	194.8263	.0000	.0445	194.8708	8
13 A 4	578.42	4399.94	.0837	.0837	3.2543	3.4000	3.4837	24
14 A 3	576.43	4399.95	49.8623	51.6786	3.0888	3.0888	54.7674	9
15 A 5	578.43	4401.96	7.9795	7.9803	1.7745	1.8009	9.7811	21
16 A 9	578.43	4405.95	.0000	.7536	1.1665	1.1665	1.9200	25
17 A 2	574.43	4399.96	.0000	13.8389	1.6338	1.6338	15.4727	17
18 A 10	580.41	4405.92	.0000	.0000	.8464	.8464	.8464	29
19 A 8	574.43	4405.96	.0000	.5625	1.0529	1.0529	1.6154	26
20 A 7	570.87	4403.94	.0000	.0000	.4950	.5121	.5121	33
21 A 13	582.41	4403.92	.0000	.0000	.5493	.6120	.6120	31
22 A 12	580.41	4403.92	.0000	.0000	.5444	.6414	.6414	30
23 H 0	572.00	4400.87	.0000	26.2047	.1834	.3421	26.3464	13
24 H 0	574.00	4400.87	.0000	8.6046	1.2702	1.2702	9.8749	20
25 H 0	580.00	4400.87	.0000	.0000	.2272	.3489	.3489	37
26 H 0	571.00	4402.60	.0000	.0214	.3706	.4890	.5104	34
27 H 0	573.00	4402.60	.0000	19.4521	.2353	.3536	19.8057	14
28 H 0	575.00	4402.60	.0000	9.4123	.1610	.1610	9.5734	22
29 H 0	577.00	4402.60	.0000	29.5180	.3822	.3822	29.9002	12
30 H 0	572.00	4404.33	.0000	.0028	.5696	.5696	.5724	32
31 H 0	574.00	4404.33	.0000	7.2180	.2755	.2755	7.4933	23
32 H 0	576.00	4404.33	.0000	10.9682	.1248	.1248	11.0931	19
33 H 0	578.00	4404.33	.0000	45.5482	.4121	.4121	45.9603	10
34 H 0	571.00	4406.06	.0000	.8200	.3788	.3788	10.1988	27
35 H 0	573.00	4406.06	.0000	.0001	.4319	.4319	.4320	36
36 H 0	577.00	4406.06	.0000	12.9563	.0959	.0959	13.0522	18
37 H 0	572.00	4407.79	.0000	.0000	.1342	.1342	.1342	39
38 H 0	574.00	4407.79	.0000	.0000	.4364	.4364	.4364	35
39 H 0	576.00	4407.79	.0000	.9420	.0000	.0000	.9420	28
40 H 0	578.00	4407.79	.0000	15.2102	.4971	.4971	15.7073	16
41 H 0	580.00	4407.79	.0000	.0000	.2645	.2645	.2645	38

Figure 11-3. Example RAM Runs

*These concepts are briefly discussed in Lesson 8 on the SCREEN2 Model.

Supplementary Reading

Turner, D.B. and Novak, J.H., 1978. *User's Guide for RAM*. EPA Pub. No. EPA-600/8-78-016, Vols. a and b. The user's guide is available for downloading in a WordPerfect® file from the SCRAM BBS (see Lesson 7).

Review Exercises

1. The RAM model is a _____ plume model.

2. True or false? The RAM model adjusts for simple terrain receptor sites.

3. The RAM model is currently recommended for application to _____ areas only.

4. The RAM model uses:
   a. Briggs' recommended urban dispersion curves
   b. Surface wind to represent stack-top wind
   c. The preprocessor program to check source data
   d. Holland's plume rise methods
   e. The method of collocated stacks for point sources

5. True or false? The RAM model uses a linear formula of the form $Y = a + bx$ to adjust the wind speed to stack height.

6. The RAM model will treat:
   a. Building downwash
   b. Fumigation
   c. Complex terrain
   d. Volume sources
   e. Stack-tip downwash

7. True or false? The RAM model is termed a multisource model.

8. True or false? The RAM model requires (x,y) coordinates for each stack to account properly for the source-receptor geometry.

9. RAM can handle up to _____ point sources.

Review Answers

1. Gaussian
2. False
3. Urban
4. a. Briggs' recommended urban dispersion curves
5. False
6. e. Stack-tip downwash
7. True
8. True
9. 250